# Solar Thermal Electricity: Power from the Sun's Heat

Sandia National Laboratories/PIX01332

*The assembly system used by Luz International for its parabolic-trough generating plants.*

## Overview

Solar thermal electric systems provide utilities with a variety of modular power options, some of which can be constructed in a relatively short period of time. There is currently about 365 MW of utility-connected solar thermal generating capacity, all of it installed in California.

More than 250 people are directly employed in the operation and maintenance of 354 MW of solar thermal trough systems in California. A fossil-fuel-fired plant producing the same amount of electricity would employ only about 100 people. A 1994 study by the California Energy Commission also revealed that solar thermal power plants yield twice as much tax revenue as conventional, gas-fired plants producing the same amount of electricity.

## Success Stories

The three types of solar thermal electric technologies — troughs, power towers and dish systems — are in different stages of development. Troughs have a proven track record, power towers are in the demonstration stage — which means that they are close to commercialization — and dish/engine systems are still under development.

### Solar Troughs: Proven Success

Parabolic trough systems have already proven themselves in the field. Nine solar electric generating systems (SEGS) totaling 354 MW have been operating successfully in California, some for more than a decade. Their availability to produce power when the sun is shining is greater than 92%, a statistic that rivals utility-scale power plants of any type.

The SEGS systems were all built by a private company, Luz International, between 1984 and 1991. These systems are still operating successfully, producing more than 90% of the world's solar thermal electricity and saving the energy equivalent of 2.3 million barrels of oil every year.

*"The SEGS provide employment to over 250 skilled operators, craftspersons, and professionals, and millions of dollars in contracts to local vendors."*

**— KJC Operating Company, which manages five of the SEGS plants (Clean Power Day 1996 prospectus)**

In 1991, Luz employed more than 700 people. According to Michael Lotker, formerly Luz's vice president of business development, each of its 80-MW SEGS plants required about 1 million job hours (500 job years) to construct. Because maintenance of the SEGS solar field is more labor-intensive than maintenance of a fossil-fuel power plant, the solar plant pays higher payroll taxes.

It has been estimated that, over their 30-year life, the operation and maintenance of each of the 80-MW plants will contribute $11.6 million in taxes to the local government, $65.8 million to the state, and $228.9 million to the federal government.

### The Solar Two Power Tower

Solar Two, in California's Mojave Desert, is a 10-MW, second-generation demonstration project to confirm the technical and economic viability of power towers. The plant uses a field of 1926 heliostats located around a 300-foot tower to focus solar radiation onto a central receiver. Molten salt is used as the heat exchange and storage medium, providing up to three hours of dispatchable power after the sun goes down.

The project has been financed by a consortium of electric utilities and high-tech companies (led by Southern

California Edison) and the U.S. Department of Energy. The industry consortium is currently involved in discussions about using the experience gained from Solar Two to build a commercial 30-100 MW power tower in Nevada, a project that would create many new jobs.

*"Solar Two represents both a new source of clean power for California and neighboring states, and a new source of export technology for America and jobs for American workers."*

**— John Bryson, chairman of Southern California Edison, at the Solar Two dedication in June 1996**

Solar Two gives an indication of the range of jobs that would be required to operate and maintain power towers once they are commercialized. The demonstration project employs nine full-time staff: three people to operate the plant's control systems plus a maintenance crew consisting of two full-time mirror washers and their truck driver, an instrument technician, an electrician, and a mechanic.

### Dish/Engine Systems: Future Opportunity

Although dish/engine systems are still under development, the prospects for this technology look promising. The systems are transportable and are appropriate for both on-grid and remote applications. Science Applications International Corporation (SAIC), a solar dish developer, plans to produce five precommercial, 25-kW systems by 1999. SAIC also expects to be producing 1000 commercial dish/engine systems per year by 2002, creating 500 high-tech jobs at a manufacturing facility in the Southwest and an additional 1000 jobs at supplier facilities throughout the United States.

Warren Gretz, NREL/PIX02407

***Solar Two technician Hugh Reilly inspecting one of the 1926 heliostats (mirrors) that track the sun during the day. Power towers provide a variety of jobs in systems operation and maintenance.***

## How It Works

Unlike photovoltaic systems, which generate electricity directly from *light*, solar thermal power systems use the *heat* from the sun's rays to generate power. Reflective surfaces concentrate the sun's rays to heat a receiver filled with oil or another heat-exchange fluid. The heated fluid is then used in some form of heat engine to generate electricity. Mechanical drives slowly turn the reflective surfaces during the day to keep the solar radiation focused on the receiver. There are three main types of solar concentrators used in solar thermal electric systems:

*Parabolic trough systems* concentrate solar rays onto a receiver pipe located along the focal line of a curved, trough-shaped reflector. The synthetic oil flowing through the pipe is heated to as much as 750°F. The hot oil is used to boil water to make steam, which runs a conventional steam turbine to generate electricity.

*Power towers*, also called central receivers, use a field of sun-tracking mirrors (heliostats) to reflect solar radiation onto a receiver that sits on top of a tall tower. The fluid in the receiver is heated to as much as 1050°F before being passed through a heat exchanger to produce the steam used to generate electricity.

*Parabolic dish systems* are similar to trough systems except that they use a dish-shaped reflector. The dish concentrates solar radiation onto a receiver mounted at the focal point of the dish, heating the receiver fluid to as much as 1500°F. Instead of boiling water to run a steam turbine, most dish systems today generate electricity by using the hot fluid to run a Stirling engine mounted at the dish's focal point.